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DEVELOPMENT OF TECHNOLOGICAL DECISIONS ON PRODUCTION OF CAPSULATED PRODUCTS BASED ON DAIRY RAW MATERIALS

Nataliya Grynchenko
Department of Meat Processing Technologies
Kharkiv State University of Food Technologies and Trade
333 Klochkivska str., Kharkiv, Ukraine, 61051
tatagrin1201@gmail.com

Pavlo Pyvovarov
Department of Food Technology
Kharkiv State University of Food Technologies and Trade
333 Klochkivska str., Kharkiv, Ukraine, 61051
pcub@ukr.net

Abstract

Capsulated products is a segment of the food industry with high rates of development in directions of creating analogues of black and red caviar, oil-fatty capsulated products, capsulated sauces, capsules, based on milk raw materials and also getting capsules with probiotic properties. It is determined, that milk is used as a "passive" recipe component (excretion of separate components, matrix for bifidobacteria) with the additional use of CaCI2 for realizing encapsulation processes. It determines the aim of the studies – development of new technological principles and approaches to the technologies of processing dairy raw materials taking into account their chemical and technological potentials. At that there is offered to use the potential of lactocalcium of whey for realizing the encapsulation process that gives a possibility to exclude auxiliary substances, especially CaCI2 from the technological process. There was developed the innovative plan of products, within which there is presented the conception of new products, their competitive advantages, determined the segment of users and consumers. There was elaborated the technological process of producing capsulated products, based on dairy raw materials involving secondary milk products, especially whey. It is noted, that the necessity of introducing whey is conditioned by its properties to be a donor of ionic calcium that is a condition of encapsulation process realization. There were studied the ways of the development of the technology of capsulated products, so a possibility of getting both fermented products and pasteurized ones appears at the expanse of thermostable properties of the coat of capsulated semi-products. It is determined, that the offered technological decisions allow to define directions of milk processing, to create products with high food properties and to offer products of new commodity forms – soft capsulated snack cheeses, soft capsulated dessert cheeses. It is proved, that the technological process of producing capsulated products taking into account consuming advantages provides the effectiveness of business functioning in the link "milk industry-restaurant industry-consumer".

Keywords: capsulated products, encapsulant, dairy raw materials, lactocalcium, soft cheese.

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1. Introduction

The evolution of food technologies is not separated from the social development. It is dictated and determined by the condition of the scientific-technical level of the society and social demand for progress. The social demand in nutrition must be understood as the improvement of the food status of consumers, growth of the food factor influence on their health and welfare, readiness of the society to pay for high-quality nutrition as a social service and conscious crediting the nutrition development for future generations.

The social responsibility of scientists of the food industry is in the conscious choice and introduction of technological and organizational methods of influence on food systems in the food industry that will guarantee creation of food products and food systems corresponding to modern requirements of nutritiology, consumers' purchasing power. The economic accessibility of new food products as a result of the practical realization of scientific trends is in fact dictated by the strategic choice of a direction of the food industry development:

– a direction, connected with introducing principally new (revolutionary) technological approaches and so new types of equipment and so, management. This approach usually needs involving research results in fundamental knowledge fields to the food industry, also material studies, constructing, training of correspondent engineering and special personnel. This direction is connected with the essential level of financing and results in appearance of more organized integral food systems and reconstruction of architectonics of food enterprises and logistic systems;

– a direction, connected with the improvement of existent food technologies (systems, links) so, with more effective use of food raw materials at the expanse of their deepened processing, creating products with the additional cost. Such approach is less estimated and accompanied by accepting evolutionary stages of the food industry development;

– a mix direction that combines the aforesaid ones and allows to involve local revolutionary scientific and technological achievements to technological cycles on evolutionary development principles. Under conditions of limited financing it is more optimal.

One of directions that develops intensely during the last time is creation of structured food products [1, 2] In the world practice it is prospective in the technology of structured products to create capsulated and granulated products that provides formation of new texture properties of food products, increase of their storage terms, realization of the controlled release of bioactive micronutrients [3–5].

Thus, there are scientifically grounded the technological parameters of encapsulation of oil-fatty raw materials – sunflower, olive, soy oils; technology of encapsulation of refractory fats and their mixtures for culinary and confectionary products; technology of encapsulation of vegetable oils, enriched with fat-soluble vitamins, fish fat; technology of dressing, salad fillings, ready to consumption, with different taste characteristics [6, 7].

We know the method of encapsulation of water-fat emulsions using sodium alginate. The developed technological principles allowed to ground scientifically and to develop technologies of an analogue of black caviar, to create capsulated products with new consumer properties, to widen the assortment of culinary products of enterprises of restaurant economy [8].

The special importance is acquired by technologies of capsulated sauces, especially mayonnaises, mustards, tomato sauces [9]. Such approaches allow to get traditional sauces in innovative commodity forms – capsules with the thermostable coat. It allows to use them in technological processes of enterprises of restaurant economy (as sauces for decorum, for stuffing and so on), and also in production cycles of enterprises of the meat branch (at producing sausage products), milk industry (in technology of hard and soft cheeses), at producing bake and so on.

The direction of development and introduction of the technology of capsulated products with probiotic properties is also prospective [10, 11]. Such approach determines a possibility of forming probiotic capsules, which use in a composition of food products allow to enrich them with healthy microflora and to give products special and dietetic status.

There are known studies, within which microencapsulation of *Bifidobacterium longum* is realized using extrusion methods in different matrixes. Especially, there is offered to use whey (of cow or goat milk) and structure-creator sodium alginate as a matrix. Such choice of a matrix is

conditioned by the fact that milk raw materials are the natural medium, where bifidobacteria are able to keep physiological activity for the maximal time. The use of sodium alginate, combined with calcium chlorine, provides getting dense microcapsules (granules) [12].

The new direction is encapsulation of separate components of milk raw materials, especially, milk proteins, milk fat, lactose. At preliminary extraction such way allows to concentrate determined substances as an encapsulant, to enrich food products and to raise their food and biological value [13].

Based on it, it must be noted, that milk is a promising raw material for getting capsulated products. But the conducted studies demonstrate that in such cases milk is used as a "passive" recipe component (matrix for bifidobacteria), additionally using $CaCI_2$ for realizing the encapsulation process. And milk is a raw material for extracting its separate components with their further use as encapsulants.

Based on it, the aim of the studies is the development of new technological decisions on producing capsulated products, based on dairy raw materials. This approach is not typical for the technology of milk products and needs studying and detailing. It determines a necessity of developing and confirming new technological principles and approaches to the technology of processing dairy raw materials taking into account their chemical and thermodynamic potentials. At that there is offered to use the potential of lactocalcium of whey for realizing the encapsulation process without using auxiliary substances, especially $CaCI_2$. Within certain technologies it allows to determine directions of milk processing and to create products with high food properties and to offer new consumer forms.

From the practical point of view, the offered technological decisions provide the increase of the effectiveness of functioning of enterprises of the milk industry at the expanse of the rational use of raw material resources (whey), increase of eco-friendliness of production processes that, in whole, favors the competitiveness of food enterprises at the Ukrainian food market. The involvement of secondary milk raw materials allows to decrease the prime cost of products and to realize resource saving principles. The use of semi-products in HoReCa segment allows to introduce industrial technologies with using capsulated semi-products, to get products with new consumer properties – food value, storage term.

2. Materials and Methods

The main objects of these studies were:

– whey (skim milk, condensed milk, dry milk), supplied by SCCT "Zmyiv milk factory" (Zmyiv city, Ukraine);

– whey, produced by SCCT "Zmyiv milk factory" (Zmyiv city, Ukraine);

– recipe mixtures for encapsulation, based dairy raw materials and whey;

– complex-creator – sodium alginate (AlgNa) FD-157 (produced by «Danisco», Denmark);

– capsulated products, based on milk raw materials.

Recipe mixtures for encapsulation, including dairy raw materials and whey, were gotten by blending recipe components (milk:whey) at ratio (100:0)–(0:100).

Capsulated products were gotten under production conditions of "Capsular" company (Ukraine) on the encapsulating device (**Fig. 1**) [14].

The principle of its action is reduced to the following. An encapsulant (dairy raw material from reservoir 1 is taken to extrusion head 3 by pump 2. At outgoing from the head, the decay of the system in drops of the necessary size takes place. Drops come through specially constructed reservoir 4 to the product pipe, where Na-Alg solution is transported as a circulating laminar flow that is a coat-creator. At combining a drop with AlgNa solution a coat is created, its thickness, physical-chemical and organoleptic characteristics at observing other technological requirements depend on the time of staying and speed of capsules' rotating in AlgNa receiving medium. After achieving necessary characteristics, the formed capsule is separated using net 2 from the forming solution.

The photo image of a production line of capsulated and granulated products is presented on **Fig**. **2.**

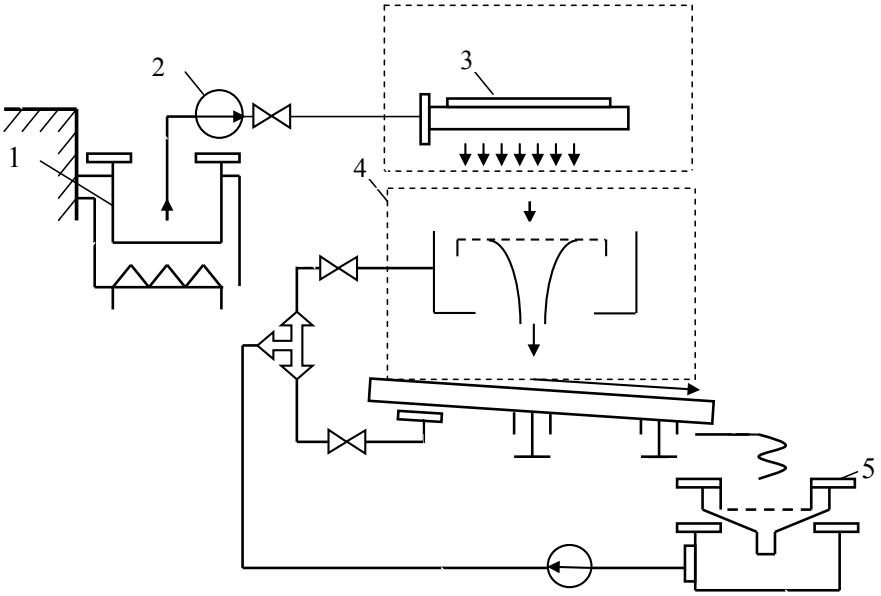

Fig. 1. Schematic image of the device for encapsulation

Fig. 2. Photo image of a production line for getting capsulated and granulated products with the capsule diameter d=(1,0–10,0)·10^{-3} m, power 100 kg/hour

The experimental studies were conducted in the laboratory of rheological studies of Kharkiv state university of food and trade (Ukraine) and under production conditions of "Capsular" company (Ukraine).

3. Results

Creation of a coat in the process of encapsulation of food products it is a complicated process that results in the phase transfer of a part of an encapsulant from the liquid state to the solid-like one. At that the main condition of encapsulation process realization by ion-tropic gel-creation is a presence of enough ionic calcium in an encapsulant. Under these conditions from the chemical point of view, this process may be considered as an ion-exchanging reaction, at which sodium ions are replaced by doubly charged calcium ions.

It is determined, that whey, taking into account its chemical composition, can play the role of a donor of free calcium ions, in such a way providing capsulated forms of milk raw materials. That is why creation of capsulated products based on milk raw materials by the method of ion-trop-

ic gel-creation is a principally new task. There is formulated the scientific idea of the study – the use of whey in the composition of whey-milk mixtures at the controlled content of lactocalcium allows to regulate the technological process of getting capsulated products with new consumption properties.

According to this idea, there was elaborated the innovative plan of new products, presented in **Table 1.**

Table 1

Innovative plan of capsulated products

Innovative parameters	Characteristics
Name of product	Capsulated products based on milk raw materials (skim milk, condensed milk, dry milk) and milk whey
Conception of product	Capsulated products as semi-products of multi-functional technological destination are characterized by the stability of properties at storage and at influence of technological factors (pasteurization, UHF-processing)
Competitive advantages	Creation of capsulated products with new consumption properties allows to widen the assortment of products, based on dairy raw materials and milk whey. The use of an auxiliary raw material (whey) is promising from the point of view of the prime cost of a product and its high biological value
Segment of users and consumers	B2B: HoReCa (enterprises of restaurant economy of different formats, including net ones; restaurants in hotels and so on); food places at educational institutions, industrial enterprises, organization of food of concentrated contingents B2C: large population layers through enterprises of wholesale and retailment

The innovative plan was realized within technological principles of getting capsulated products, based on dairy raw materials. The technological process of such products is conducted as following. At the first stage the recipe mixture is made. Its composition includes dairy raw materials (skim milk, condensed milk, dry milk) and milk whey (which role is in supplying a mixture with free calcium ions) and additional recipe components (if necessary): vegetable or fruit raw materials (olives, spinach, pumpkin, peach, apple, pear, fig and so on as puree), taste components (spices, honey cacao, coffee, caramel and so on) and also aromatizers and natural coloring agents that give a possibility to regulate the color and taste spectrum of capsulated soft cheeses of dessert and snack groups. At the following stage the recipe mixture is capsulated with getting capsulated semi-products of different size characteristics (1,0–15 mm). It must be noted, that the assortment row of products may be formed both at the expanse of capsules' size and additional recipe components and taste-aromatic compositions. It allows to get the wide spectrum of products, which taste characteristics may be presented by the following groups: vegetable, spicy, fruit, fruit-berry, chocolate, coffee, caramel, honey and so on (**Fig. 3**).

Then the technological process can be realized by two directions. In the first case capsulated semi-products undergo fermentation by using bacterial leavens and preparations, made of strains of lactate and aroma-creating streptococci. As a result a cheese grain forms within a capsule, which becomes soft cheese after the end of fermentation.

Microflora, used at producing and ripening determines the type and specific features of soft cheeses, conditions the course of microbiological, biochemical (fermentative) processes in milk and cheese mass and also influences formation of taste and smell of soft cheeses and their physical-chemical composition and texture properties.

In the other case received capsulated semi-products are pasteurized with getting products with typical organoleptic properties. At that the coat of capsules is thermostable and doesn't collapse under the temperature influence. The internal content of capsules is homogenous, delicate, plastic, moderately dense and juicy.

At the final stage the received capsulated products are poured with brine or syrup, depending on the assortment row of products.

a

b

c

d

Fig. 3. Outlook of capsulated products, based on milk raw materials and whey: *a* – soft capsulated cheeses «PERLINI» (d=0,2–0,4 mm); *b* – soft capsulated cheeses «CHERRY» (d=0,5–1,2 mm); *c* – milk capsulated products «SWEET MILK» with the strawberry taste; *d* – capsulated milk products «SWEET MILK» with the chocolate taste

Thus, the applied aspect of the offered technological decisions is realization of the scientific-practical direction on the complex processing of milk, within which the new food forms are created – soft capsulated dessert cheeses and soft capsulated snack cheeses. At that the basic moment is to realize the principles of resource-saving, ecologization of production, increase of effectiveness, creation of the high prime cost of new products that in whole provides the effectiveness of business functioning in the link "milk industry-restaurant industry-consumer".

4. Conclusions

There were analyzed the modern tendencies in the technology of capsulated products. It was determined, that this direction actively develops in the segment of creation of analogues of

black caviar, oil-fat capsulated products, capsulated sauces and also getting capsules with probiotic properties. There was determined the promising character of realization of the scientific-practical direction on the complex processing of milk, within which the new food forms are created – soft capsulated dessert cheeses and soft capsulated snack cheeses.

There was developed the innovative plan of products, within which there is presented the conception of new products, their competitive advantages, determined the segment of users and consumers.

There was developed the technological process of capsulated products as soft cheeses, within which the encapsulation process is realized at the expanse of lactocalcium of milk whey. The assortment row was developed taking into account consuming advantages. The offered technological principles provide the effectiveness of business functioning in the link "milk industry-restaurant industry-consumer".

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